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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPELLANTS:	Flohr et al.	CONFIRMATION NO. 5375
SERIAL NO.:	10/675,302	GROUP ART UNIT: 2882
FILED:	September 30, 2003	EXAMINER: Craig E. Church
TITLE:	"METHOD AND APPARATUS FOR PRODUCING A COMPUTED TOMOGRAPHY IMAGE OF A PERIODICALLY MOVING ORGAN"	

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APPELLANTS' MAIN BRIEF ON APPEAL

S I R:

In accordance with the provisions of 37 C.F.R. §41.37, Appellants herewith submit their main brief in support of the appeal of the above-referenced application.

REAL PARTY IN INTEREST:

The real party in interest is the assignee of the present application, Siemens Aktiengesellschaft, a German corporation.

RELATED APPEALS AND INTERFERENCES:

There are no related appeals and no related interferences.

STATUS OF CLAIMS:

Claims 1, 2, 4-8 and 10-18 are the subject of the present appeal, and constitute all pending claims of the application. All of those claims were rejected in the final rejection dated November 16, 2005. Claims 3 and 9 were cancelled during prosecution before the Examiner.

STATUS OF AMENDMENTS:

An Amendment under 37 C.F.R.§ 1.116 and 37 C.F.R.§ 41.33(a) was filed subsequent to the final rejection, to make editorial changes in claims 1 and 8.

Claim 8 originally depended from dependent claim 3 which, in turn, depended from original independent claim 1. As noted above, during prosecution before the Examiner, claim 3 was cancelled, and the dependency of claim 8 was inadvertently not changed. The aforementioned Amendment was filed solely for the purpose of correcting the dependency of claim 8, to change the dependency of that claim from claim 3 to claim 1.

The Amendment also corrects an obvious typographical error in claim 1.

Since Appellants believe this Amendment is fully compliant with the prerequisites for the entry thereof under 37 C.F.R.§ 1.116, Appellants assume the Amendment will be entered, but as of the date of filing of this Appeal Brief a Decision by the Examiner has not yet been made. In view of the expectation that this Amendment will be entered, claims 1 and 8 in the Claim's Appendix herein embody the changes that were made in the Amendment.

SUMMARY OF CLAIMED SUBJECT MATTER:

The claims on appeal concern a method and computed tomography (CT) apparatus for operating images of a periodically moving organ of an organism, the organ having regions with rest and movement phases with the rest phases of different regions ensuing at different points in time. The claimed method and CT apparatus are of the type wherein an x-ray source is moved around the body of the organism to be examined to the CT images, to obtain a number of projections serving for the image generation during at least one rotation of the x-ray source

around the subject to be examined and during a duration that is at least equal to a period of the motion. (p.1, l.7-14)

Methods and systems of this type are used to generate computed tomography images of the heart that show the heart in a rest phase. (p.1, l.16-17)

With known CT methods and systems, it is generally not possible to develop computed tomography images of the coronary arteries that contain little movement artifacts, that are useful for the determination of the degree of calcification or the diagnosis of stenoses in the coronary arteries. The regions of the heart that must be imaged for such examinations in computed tomography images lacking movement artifacts are the right coronary artery (RCA), the left aorta (LM = Left Main), left arterial circumflex (LCX) and the left descending artery (LAD = Left Artery Descendent). For the four cited regions, the speed and the phase of the spatial movement are respectively different during a heart cycle. (p.1, l.18-26)

Since the position of the diastolic phase of the heart can be evaluated, for example from an ECG signal of the patient acquired during the examination, and the ventricles as well as LM and LAD are largely at rest during diastole, it is a common procedure to acquire ECG-triggered axial scan data for representations of the heart lacking movement artifacts. In addition, it is known to first acquire data and to simultaneously record the ECG signal with the data acquisition, in order to then retrospectively determine, using the ECG signal, the data that were acquired during diastole, and to reconstruct an image based on this data. (p.2, l.1-8)

The reconstruction of an image of the heart based on data that was determined during diastole, however, in general allows no sharp imaging of RCA and LCX, since their movement in the diastole can be significant. Only with electron

beam computed tomography (EBT) (due to the short scan times per slice (looms) with these devices) can a measurement interval sometimes be found in a phase of the heart cycle during which the four cited arteries exhibit only little motion. For patients with higher pulse rates, this does not work for the most part. With conventional computed tomography devices common today, that employ scan times of not less than 330 ms per slice, it is impossible, for patients with lower pulse rates to find a measurement interval in which all cited regions exhibit relatively little motion. (p.2., l.9-18)

The problem is solved by the method and apparatus of the claims on appeal, that allow computed tomography images of a periodically moving organ of an organism (the organ having regions with rest or movement phases with the rest phases of different regions of the organ ensue at different points in time) to be generated by moving an x-ray source around the body of the organism to be examined to generate the computed tomography images, including the steps of acquiring a number of projections serving for image generation during at least one rotation of the x-ray source around the subject to be examined and during a duration that is at least equal to one period of the movement, analyzing the data corresponding to the projections as to whether the data were acquired during a rest phase or a movement phase of a respective region of interest of the organ, and reconstructing of an image of the organ using only data acquired during a rest phase of the respective region of interest of the organ. (p.2, l. 24 - p3. 1.10)

As shown in Fig. 1 and 2 of the application, the spatial motion of the coronary arteries and the heart ventricles vary in speed and phase in the slice plane under consideration during a heart cycle. (p.6, l. 18-20) Figs. 1 and 2 show the same slice

place of a heart, however the data respectively forming the basis of Figs. 1 and 2 were acquired during different time periods within a heart cycle. (p.6, l. 20-22) Fig. 1 thus shows the diastolic rest phase that begins after approximately 30% of the total duration of a heart cycle and ends after approximately 70% of the total duration of a heart phase (30%-70%-R interval). (p.6, l.22-24) Fig. 2 shows the systolic contraction phase (80%-120%-RR interval). Both images were reconstructed with 250 ms time resolution. (p.7, l.1-2)

It can be clearly recognized from using Fig. 1 that in diastole the entire heart is sharply visible in the region of the left ventricle, while the depiction of the RCA is severely impaired by conditional smearing arising due to motion. (p7., l.3-5)

In contrast, the image reconstructed in systole according to Fig. 2 shows the RCA sharply and the region around the left ventricle is in contrast shown with movement artifacts. (p7, l.6-8)

It is thus evident that the left ventricle and RCA move out of phase. This conclusion is valid as well for other coronary arteries, whereby CX and RCA move substantially in phase, while LM and LAD move approximately in phase with the left ventricle. (p.7, l.9-12)

This is once again illustrated in Figs. 3 through 7 that, in the form of time diagrams, show the movement speed of different regions of the heart during a heart cycle, thus during the time period between two successive R-waves of the ECG, whereby the ration of momentary and maximal movement speed [v/vmax] of the respective region is applied over the duration of a heart cycle [%RR] specified in percent. (p.7, l.13-18)

For artifact-free depiction of all regions of interest, according to the Figs. 3 through 7 only the phase 30%RR through 60%RR should be considered, but, in particular for higher pulse rates, this is not sufficient to acquire all projections necessary to reconstruct a CT (computed tomography) image. (p.7, l.19-22)

According the inventive method, it is not attempted to image all regions of interest of the heart during a single measurement interval. Instead, multiple projections are acquired during at least one rotation of the x-ray source around the heart and during a time duration that is at least equal to one period of the heart cycle, the projection data are analyzed as to whether the data were acquired during a rest phase or movement phase of a respective region of interest of the heart, and an image of the organ is reconstructed using only data acquired during a rest phase of a respective region of interest of the organ. (p.7, l.23 - p.8, l.5)

As is shown in Fig. 8, two different intervals (δ_1,ε_1) for LAD and LM as well as (δ_2,ε_2) for RCA and LCX are used for image reconstruction. δ_n defines the start point, dependent on the occurrence of the R-wave initiating a heart cycle, ε_n defines the duration of the interval of an RR cycle dependent on the duration ΔT_{RR}. (p.8, l.6-9)

A computed tomography device to implement the above-described method is schematically shown in Fig. 9. (p.8, l. 10-11)

The computed tomography device has a measuring unit formed by from an x-ray source 1 that emits an x-ray beam 2 and a detector 3 which having one or more successive lines of individual detectors in the z-direction, for example 512 individual detectors per line. (p. 8, l.12-15) The focus of the x-ray source 1 from which the x-ray beam 2 originates is indicated with 4. (p.8, l.15-16) Dependent on whether one

or more lines of individual detectors is used, the x-ray beam is gated so as to be fan-shaped or pyramid-shaped or conical by means of a primary beam diaphragm. (p.8, l.16-18)

The examination subject (in the case of the shown exemplary embodiment a human patient 5) lies on a positioning table 6 that extends through the measuring opening 7 of a gantry 8. (p.8, l.19-21)

The x-ray source 1 and the detector 3 are mounted opposite one another on the gantry 8. The gantry is centered the z-axis (indicated with z, proceeding at a right-angle to the plane Fig. 9) of the computed tomography device that also is the system axis. (p.8, l.22-24) The gantry is rotated around the z-axis by a motor 13 to scan the patient 5 in the α-direction indicated by the arrow α. This rotation proceeds through an angle that is at least equal to 180° (π) plus fan angle (aperture angle of the fan-shaped x-ray beam 2). The x-ray beam 2 originating from an x-ray source 1, which is supplied with voltage by a generator 9, irradiates a measuring field of circular cross section. The focus 4 of the x-ray source 1 move on a circular curved focus path 15 around the rotational center lying on the z-axis. (p.8, l.7-13)

At predetermined angle positions of the measuring unit 1, 3 (known as projection angles), measurement values (datasets) are acquired in the form of known as projections. The corresponding measurement data are supplied from the detector 3 to an electronic computer 11 which reconstructs the attenuation coefficients of the pixels of a pixel matrix from the projections and visually reproduces the pixel values on a display device, for example a monitor 12, on which images of the slices of the patient 5 irradiated in the projections thus appear. (p.9, l.7-13)

To implement examinations of the heart or heart-proximal regions of the body of the patient 5 moving in the rhythm of the heart action, the computed tomography device has, according to Fig. 1 a known electrocardiograph unit 17 (ECG unit) that can be connected with the patient 5 via electrodes (of which one is shown in Fig. 1 and is indicated with 18) and serves to detect the ECG signal of the patient 5 in parallel with the examination by the computed tomography device. The ECG data, preferably in digital form, are supplied to the computer 11. (p.9, l.24 - p.10, l.5)

In a basic mode of operation of the CT device based on the inventive method, an operator marks on a monitor 21, by means of a mouse 20, the region of a period of the ECG that corresponds to the rest phase of the region of the heart that should be shown in the computed tomography images. (p.10, l.13-16)

Thus in the ECG of the patient 5, with regard to the respective region of interest of the heart 1, a useable time interval lying between two successive R-waves of the ECG is marked, and the computer 11 uses only data for the image reconstruction that were acquired in the individual heart cycles respectively during the useable time interval. The computer 11 considers that data as having been acquired during a rest phase. (p.10, l.17-22)

The computer 11 identifies the position and duration of a time interval (marked as a useable time interval by the mouse 20 on the monitor 21) within a heart period, by a first fraction of the respective heart period that elapses after the R-wave commencing the heart cycle and the beginning of the usable time interval, and by second fraction of the duration of the heart cycle that follows the first fraction and corresponds to the duration of the usable time interval. (p.10, l.23 - p.11, l.3)

In this manner, it is also possible, given fluctuations of the heart period, to analyze data corresponding to the acquired projections as to whether the data were acquired during a rest phase or movement phase of the respective region of interest of the heart. The computer 11 then considers that data that was acquired during usable time intervals as data acquired during a rest phase, and subsequently uses only that data to reconstruct the computed tomography image. (p.10, l.4-9)

In the method and computed tomography device that are the subject of independent claims 1, 14 and 16 on appeal, the analysis of the data corresponding to the projections (as to whether they were acquired during a rest phase or a movement phase of the respective region of interest of the heart) is based on the detection of movement artifacts in test images. (p.11, l. 10-16)

For this purpose, a number of temporally quickly successive test images is reconstructed from the available data, and these test images that are analyzed for movement artifacts. (p.11, l.17-19)

This can ensue by computer 11 examining the test images for the existence of line artifacts and/or double contours, and considers the existence of line artifacts and/or double contours as an indication of movement artifacts. (p.11, l.20-22)

The computer 11 then considers the data that produced a test image that is substantially free of movement artifacts in at least the image region showing the respective region of interest of the heart, as acquired during a rest phase of the respective region of interest of the heart and uses such data exclusively for the actual image reconstruction. (p.11, l.23-27)

Alternatively, the computer 11 detects movement artifacts using difference images acquired by subtraction of successive test images. A difference image that

(theoretically) contains no image information at all indicates an absence of movement artifacts. (p.12, l.1-14)

In order to reduce the time for reconstruction of the test images, the computer 11 can undertake the reconstruction of the test images with reduced computing power and/or reduced resolution and/or as a partial rotation reconstruction. (p.12, l.5-7)

Another alternative for the computer 11 to reconstruct the test images not from the same data that also will be used of the reconstruction of the actual images, but rather from data that are acquired during a test mode that precedes the acquisition mode. (p.12, l.8-11)

During such a test mode (that should if at all possible immediately precede the acquisition mode), projections are acquired with simultaneous recording of the ECG from which test images are reconstructed that are shown on the monitor 12. (p12, l.12-14) An operator evaluates these images and indicates by means of the mouse 20 those images that he or she recognizes as lacking movement artifacts with regard to the respective region of interest of the heart. (p.12, l.15-17) Based on the temporal position of the test images so indicated relative to the ECG, the computer 11 determines (with consideration of the ECG signal) a useable time interval (with regard to the respective region of interest). (p.12, l.17-20) The position and duration of this time interval, as already specified, can be defined by a first fraction and a second fraction of the heart period, and indicates the rest phase of the respective region of interest. (p.12, l.20-22)

In the subsequent acquisition modes, the projections serving for the actual image generation are acquired, from which the computer 11 uses, for the

reconstruction of the respective region of interest, only projections that are acquired during a (as specified) useable time interval determined on the basis of the test images, and thus during a rest phase of the respective region of interest. (p.12, l. 23 - p.13, l.2)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL:

The following issues are presented for review in the present Appeal:

(1) whether claim 8 complies with 35 U.S.C. §112, second paragraph, by virtue of being in contradiction to claim 1, from which claim 8 depends;

(2) whether the subject matter of claims 1, 2, 4-8 and 10-16 complies with 35 U.S.C. §112, second paragraph in view of the use of the term "test image" in each of independent claims 1, 14 and 16, and by virtue of the language "computing power that is reduced compared to a computing power used to reconstruct said image of said organ in step (c)" in claim 6;

(3) whether the subject matter of claims 1, 2, 4-8 and 14 would have been obvious to a person of ordinary skill in the field of computed tomography under the provisions of 35 U.S.C. §103(a) based on the teachings of United States Patent No. 6,650,726 (Sembritzki et al.);

(4) whether the subject matter of claims 10-13 and 16-18 is anticipated under 35 U.S.C. §102(e) by United States Patent No. 6,504,893 (Flohr et al.); and

(5) whether the subject matter of claim 15 would have been obvious to a person of ordinary skill in the field of computed tomography under the provisions of 35 U.S.C. §103(a) based on the teachings of Sembritzki et al. and Flohr et al..

ARGUMENT:

Rejection Of Claim 8 Under §112, Second Paragraph Due To Being In Contradiction With Claim 1

In the last paragraph on page 3 of the final rejection dated November 16, 2005, the Examiner stated that because claim 1 requires that the images be acquired during *at least one* rotation of the x-ray beam focus, and claim 8 stipulates that images are acquired with *only a partial* rotation of the focus, claim 8 contradicts claim 1 (emphasis in original rejection).

Appellants respectfully submit that there is no contradiction between the subject matter of claim 8 and the subject matter of claim 1, because the exact language of claim 1 states that the focus of the x-ray source is rotated around an organ to be imaged, "to obtain a plurality of sets of projection data of said organ in rapid succession, each set of projection data representing a test image of said organ, during at least one rotation of said focus around said organ and during a duration that is at least equal to one period of the periodic movement of the organ." Claim 8 states that the test images are acquired "with only a partial rotation of said focus around said organ." Appellants respectfully submit that there is no contradiction between claims 1 and 8 because claim 1 merely requires that the sets of projection data, that respectively represent test images of the organ, are obtained *during* at least one rotation of the focus. Claim 8 then states that the test images are acquired with only a partial rotation of the focus around the organ. Clearly, a "partial rotation of the focus around the organ" must occur *during* at least one rotation of said focus around said organ, and thus there is no contradiction between claims 1 and 8. Claim 1 allows for the possibility of the focus executing multiple rotations around the organ, and it is possible that test images could be acquired during more than one of

these multiple rotations. In accordance with claim 8, however, in each rotation in which test images are acquired, they are acquired with only a partial rotation of the focus around the organ. Simply because claim 8 states that the test images are acquired with only a partial rotation of the focus around the organ does not mean that the rotation of the focus is physically only a partial rotation (since it is well known that the x-ray source focus continually rotates during a CT scan), but simply means that the test images are acquired within only a portion of one complete rotation of the focus around the organ.

Appellants therefore respectfully submit that claim 8 is in full compliance with all provisions of §112, second paragraph.

Rejections Of Claims 1, 2, 4-8 And 10-16 Under §112, Second Paragraph Due To The Use Of The Term "Test Image" And Due To The Use Of The "Computer Power..." Phrase In Claim 6

At page 2 of the Final Rejection, the Examiner stated that any image of a medical subject may be regarded as a "test" image, and the patentable difference between a test image and other images has not been defined. The Examiner also stated that the meaning of the phrase "computing power that is reduced compared to a computing power used to reconstruct said image of said organ in step (c)" in claim 6 is unclear. Since this phrase in claim 6 was intended to claim one way that a "test image" can be obtained, namely with a computing power that is reduced compared to that used to reconstruct the image of the organ in step (c) of claim 1, these rejections are related, and will be argued together.

First, although the Examiner may be correct as a general proposition that any image of a medical subject may be regarded as a "test" image, the explicit language of claim 1 clearly differentiates test images from the diagnostic image that is

reconstructed in step (c) of claims 1 and 16, and in the last claim element of claim 14. In this regard, the term "test images" was intended to have its normal dictionary definition, comparable to the term "test case," as meaning a representative image that can be used as a precedent or predictor for the ultimate purpose of reconstructing a diagnostic image during the rest phase of the organ in question. The fact that independent claims 1, 14 and 16 use the separate terms "test images" and "diagnostic image" compels an interpretation of those claims that does not assume that a "test image" is the same as the diagnostic image. One of the canons of claim construction is that a claim will not intentionally be interpreted in a manner that renders elements therein redundant or duplicatively claimed, if a reasonable interpretation exists that avoids such redundancy. Two differently-designated terms in a patent claim are entitled to the assumption that they are, in fact, intended to designate two different things, unless there is something in the other claim language that compels the conclusion that they are identical. Appellants submit that no such language is present in any of independent claims 1, 14 and 16 that compels the conclusion that a test image is indistinguishable from the diagnostic image. Those of ordinary skill in the field of radiology recognize a diagnostic image as an image from which a diagnosis (finding) can be made, and this means that a diagnostic image must inherently exhibit a level of detail or resolution that allows at least some type of diagnostic finding to make therefrom.

Within the context of each of claims 1, 14 and 16, the only conclusion that need be made regarding the scope and meaning of the term "test images" is that a test image is *not* the diagnostic image. Since this is abundantly clear from the explicit language of each of those claims, the use of the term "test images" in those

claims does not render any of those independent claims as being indefinite or unclear under the provisions of §112, second paragraph.

With the exception of claim 6, the inclusion of the dependent claims in this rejection under §112, second paragraph appears to follow from the rejection of the independent claims. Therefore, with the exception of dependent claim 6, Appellants submit that dependent claims 2, 4, 7, 8, 10-13 and 15 are in compliance with §112, second paragraph for the same reasons discussed above with regard to the independent claims.

As to claim 6, as noted above the language cited by the Examiner in that claim provides an explicit example of how a test image can be acquired, namely with a lower computing power than is used to reconstruct the image of the organ in step (c). The image of the organ that is reconstructed in step (c) is, as noted above, a diagnostic image, and therefore claim 6 merely allows for the test images to be obtained with a lower computing power, because all that is necessary to ascertain from the test images is an identification of the rest phase, and thus the reconstruction algorithm can be much less computationally-intensive than for the high resolution image (diagnostic image) from which a diagnosis must be made. This is supported in the specification as originally filed at page 12, liens 5-7 (included in the Summary of Claimed Subject Matter above), which provides other examples, such as acquiring the test images with a reduced resolution or as a partial rotation reconstruction. The "partial rotation reconstruction" is the alternative set forth in claim 8, discussed above.

Therefore, since the term "test images" in claim 1, from which claim 6 depends, in not unclear, indefinite or ambiguous, and since the aforementioned

phrase in claim 6 simply sets forth one example of how such "test images" can be obtained, the subject matter of claim 6 in full compliance with all provisions of §112, second paragraph.

Rejection of Claims 1, 2, 4-8 and 14 Under 35 U.S.C. §103(a) Based on Sembritzki et al.

In the first paragraph at page 3 of the final rejection, claims 1, 2, 4-8 and 14 were stated to be "rejected under 35 U.S.C. §103(a) as being anticipated by Sembritzki et al. (6,650,726)." Since the Examiner acknowledged in that same paragraph that the Sembritzki et al. reference does not describe the images obtained therein as being "test" images, but the Examiner stated medical images are obviously for clinical testing, Appellants assume the use of the term "anticipated" at that location in the final rejection was an oversight and this rejection, consistent with the citation of 35 U.S.C. §103(a), was intended to be an obviousness rejection.

The distinction between "test images" and a "diagnostic image" has been discussed above, and that distinction is relevant to the rejection of these claims as being obvious in view of the teachings of Sembritzki et al. Appellants respectfully submit that whether medical images are "obviously" for clinical testing is not a relevant inquiry for assessing the patentability of claims 1, 32, 4-8 and 14 under 35 U.S.C. §103(a).

Appellants respectfully submit that claims 1 and 14 require more than merely acquiring multiple images, some of which may be for testing. The term "test images" is used to designate the images (sets of projection data) that are acquired and then analyzed to determine which of those test images were acquired during a rest phase of the organ in question, and which of those test images were acquired during a movement phase of the organ. A diagnostic image of the organ is then

reconstructed using only projection data from the test images that have been identified as being acquired during the rest phase. Moreover, independent claims 1 and 14 specifically describe the manner by which the sets of projection data are analyzed to determine whether the test image containing the projection data was acquired during a rest phase, or during a movement phase.

The Sembritzki et al reference discloses a method wherein movement artifacts are detected by comparing projection data in question with complementary projection data, offset by 180°. This has the disadvantage, as discussed at column 3, lines 8-25 of the Sembritzki reference itself, of not permitting a recognition to be made as to whether the data of the projection or their complementary data are falsified by movement of the examination subject. The Sembritzki et al reference discloses a computed tomography apparatus and method to avoid that problem.

By contrast, in the method and apparatus set forth in claims 1 and 14, movement artifacts are not detected by analyzing a series of complete, diagnostic images, but instead are detected by analyzing a sequence of images obtained in rapid succession (the test images) and, as set forth in claim 8, the test images can be generated by only a partial circumferential reconstruction (partial rotation of the focus around the organ). The test images in which the motion artifacts are detected, therefore, are not the same image, or one of the images, that is then used as the diagnostic image. By contrast, the diagnostic image is generated using only projection data from test images that have been identified as having been acquired during the rest phase of the organ.

This enables the detection for movement artifacts to be undertaken using images requiring a reduced computation capacity, so that the decision as to whether

they have been acquired during a rest phase can be made quickly. The detection of movement artifacts based on the content of the test images, rather than on the content of the actual diagnostic image, is not disclosed or suggested in the Sembritzki et al reference.

The subject matter of claims 1 and 14, therefore, would not have been obvious to a person of ordinary skill in the field of computed tomography based on the teachings of Sembritzki et al. Claims 2 and 4-8 add further method steps to the non-obvious method of claim 1, and are therefore patentable over the teachings of Sembritzki et al for the same reasons discussed above in connection with claim 1.

Rejection of Claims 10-13 and 16-18 as Being Anticipated Under 35 U.S.C. §102(e) by Flohr et al.

In the Final Rejection at page 3, the Examiner stated the Flohr et al. reference teaches an x-ray tomography apparatus having an x-ray source 1 and detectors 2 mounted on a gantry 7, an ECG monitor 28, rotation speed control 26, means for activating the source only during rest phases of the heart, and a processor 31 for reconstructing heart images acquired during the rest phase. As substantiation for the Flohr et al. reference teaching means for activating the source only during rest phases of the heart, the Examiner relied on lines 11-17 and 33-37 in column 6 of the Flohr et al. reference, and noted that a level (threshold) comparison with the ECG signal takes place, as shown in Figure 3 of the Flohr et al. reference, to designate when the x-ray source activation should occur.

Appellants agree this is an accurate description of the disclosure of the Flohr et al. reference, but respectfully submit that these teachings do not constitute an anticipation of any of claims 10-13 or 16-18. Independent claim 16 (from which claims 10-13 depend) states that the organ to be imaged comprises a plurality of

regions, each having a rest phase and a movement phase, with the respective phases of different ones of the regions ensuing at different points in time. In step (a) of claim 16, projection data representing a test image of the organ are obtained, and a signal is acquired from the organ that represents a physiological function of the organ.

In step (b) of claim 16, the sets of projection data are analyzed to determine whether the projection data were acquired during a rest phase or during a movement phase of *at least one of said regions* of said organ, and a time interval in the signal is identified corresponding to the rest phase of *said at least one of said regions,* and then projection data are identified that were obtained during that time interval. In step (c) of claim 16, the diagnostic image is reconstructed using only the projection data that were acquired during the respective rest phase of *said at least one of said regions*.

In the Flohr et al. reference, by contrast, the ECG signal is simply used to activate the x-ray source for appropriate brief periods of time during which it is identified, from the ECG signal, that the overall heart is in a rest phase. There are no test images acquired in the Flohr et al. system, nor is there any identification of at least one *region* of the heart, so as to identify when that *region* is in a rest phase, and then to reconstruct the diagnostic image using only projection data acquired during the rest phase of that *region*.

Regardless of how the term "test image" is construed (other than, as noted above, differentiating it from the "diagnostic image"), it is clear that in the Flohr et al. reference *all* of the data that are acquired are used to generate the image of the heart in the rest phase. The ECG signal is simply used to determine when to

activate the x-ray source to cause data to be acquired, but *all data* generated for all activations of the x-ray source are then used to create the diagnostic image of the heart. There is no need to analyze the acquired data (in the form of a test image or otherwise), because it is assumed, due to the activation of the x-ray source using the ECG signal, that the data that are acquired will *necessarily* be acquired during the rest phase, due to the triggering based on the ECG signal.

The Flohr et al. reference, therefore, does not disclose all of the method steps of claim 16, and thus does not anticipate claim 16 or any of claims 10-13 depending therefrom.

Independent claim 17 does not require the generation of test images, but tracks method claim 17 with regard to using the projection data in combination with the signal representing a physiological function of the organ to determine whether the projection data in each set were acquired during a rest phase of *at least one of the regions* of the organ, and an image of the organ is reconstructed using only projection data from the respective rest phase of the *at least one region,* by identifying a time interval in the signal corresponding to the rest phase of *at least one of the regions*, and identifying projection data for *that region* that were obtained during that time interval.

As in claim 16, therefore, in claim 17, the physiological signal is used to identify a rest phase of a *region* of the organ, and then the image of the (overall) organ is reconstructed using only projection data that were obtained during a time interval in which it has been determined that the *region* was at rest.

For the reasons discussed above in connection with claim 16, the disclosure of the Flohr et al. reference does not provide such a teaching. In the Flohr et al.

reference, as discussed above, projection data are obtained *only* when it has already been determined (based on the ECG signal) that the heart is at rest. There is thus no need in the Flohr et al. reference to analyze an projection data to determine whether it was acquired during a rest phase of the heart, or any region of the heart, because the Flohr et al. reference proceeds on a complete different basis, namely on the basis that, by virtue of ECG signal-triggering, data will *necessarily* be acquired *only* during the rest phase of the heart.

The Flohr et al. reference, therefore, does not disclose all of the elements of claim 17 as arranged and operating in that claim, and thus does not anticipate claim 17, nor claim 18 depending therefrom.

Rejection of Claim 15 Under 35 U.S.C. §103(a) Based on Sembrtizki et al. and Flohr et al.

Claim 15 depends from independent claim 14, the rejection of which based on Sembritzki et al. has already been discussed above. The Examiner additionally relied on the Flohr et al. reference as a basis for rejecting claim 15, because the Examiner acknowledged that the Sembritzki et al. reference does not mention the use of an ECG signal. For the reasons discussed above in connection with both the Sembritzki et al. and Flohr et al. references, however, even if the Sembritzki et al. system were modified to use an ECG signal in accordance with the teachings of Flohr et al., this would simply result in the x-ray tube in the Sembritzki et al. reference being activated only when, by virtue of analyzing the ECG signal, the heart is already determined to be at rest. This would make the rest of independent claim 1, the subject matter of which is embodied in claim 15, completely superfluous, because there would be no need to analyze projection data to determine the time of occurrence of the rest phase. In claim 15, the ECG signal is not used to trigger

activation of the x-ray source, as in the Flohr et al. reference, but instead is used in parallel (as an augmentation thereto) with the analysis of the projections representing the test images.

Claim 15, therefore, would not have been obvious to a person of ordinary skill in the field of computed tomography based on the teachings of Sembritzki et al. and Flohr et al.

CONCLUSION:

For the foregoing reasons, Appellants respectfully submit the rejections of claims 1, 2, 4-8 and 10-18 are not properly factually or legally substantiated, reversal of all of those rejections is therefore proper, and the same is respectfully requested.

Thos Appeal Brief is accompanied by a check for the requisite fee in the amount of $500.00.

Submitted by,

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CERTIFICATE OF MAILING

I hereby certify this correspondence is being deposited with the United States Postal Service as First Class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on March 20, 2006.

Steven H. Noll

STEVEN H. NOLL

CLAIMS APPENDIX

1. A method for generating a computed tomography image of a periodically moving organ of an organism, wherein the organ comprises a plurality of regions each having a rest phase and a movement phase, with the respective rest phases of different ones of said regions ensuing at different points in time, comprising the steps of:

(a) emitting an x-ray beam from a focus of an x-ray source and rotating at least said focus around said organ to irradiate said organ from a plurality of different directions, and detecting x-rays in said x-ray beam attenuated by said organ at each of said directions, to obtain a plurality of sets of projection data of said organ in rapid succession, each set of projection data representing a test image of said organ, during at least one rotation of said focus around said organ and during a duration that is at least equal to one period of the periodic movement of the organ;

(b) analyzing said sets of projection data to determine whether the projection data in each test image were acquired during a rest phase or during a movement phase of at least one of said regions of said organ by detecting movement artifacts in an image region of each test image containing said at least one region of said organ, and designating projection data in respective test images that are free of movement artifacts as having been acquired during the rest phase of said at least one of said regions; and

(c) reconstructing a diagnostic image of said organ using only projection data from said test images acquired during the respective rest phase of said at least one of said regions of said organ.

2. A method as claimed in claim 1 wherein step (b) comprising analyzing said projection data with regard to a plurality of said regions of said organ to determine whether the projection data were acquired during the respective rest phase or the respective movement phase of each of said plurality of regions, and wherein step (c) comprises reconstructing a single image of said organ using only projection data acquired during the respective rest phase of each of said regions.

4. A method as claimed in claim 1 comprising detecting movement artifacts by detecting at least one of line artifacts and double contours in the respective test images.

5. A method as claimed in claim 1 comprising detecting movement artifacts by forming respective difference images from respective pairs of successive test images.

6. A method as claimed in claim 1 comprising generating said test images with a computing power that is reduced compared to a computing power used to reconstruct said image of said organ in step (c).

7. A method as claimed in claim 1 comprising acquiring said test images with a reduced resolution in comparison to a resolution of said image of said organ reconstructed in step (c).

8. A method as claimed in claim 8 comprising acquiring said test images with only a partial rotation of said focus around said organ.

10. A method as claimed in claim 16 wherein said organ is a heart, and comprising acquiring an ECG as said signal.

11. A method as claimed in claim 10 comprising identifying said time interval occurring between two successive R-waves of said ECG.

12. A method as claimed in claim 11 comprising identifying said interval by identifying a predetermined first fraction of a period of the heart following a first of said two successive R-waves, and identifying said interval as a duration equal to a second predetermined fraction of said period following said first predetermined fraction.

13. A method as claimed in claim 16 comprising comparing said signal to a threshold criterion and activating said x-ray source to emit said x-ray beam to acquire said projections only during time segments wherein said threshold criterion is satisfied.

14. A computed tomography apparatus for generating an image of a periodically moving organ of an organism, said organ comprising a plurality of regions each having a rest phase and a movement phase, with the respective rest phases of different regions of said organ ensuing at different points in time, said computed tomography apparatus comprising:

an x-ray source having a focus from which an x-ray beam is emitted;

a radiation detector on which said x-ray beam is incident;

at least said focus of said x-ray source being rotatable around said organism to irradiate said organ in said organism from a plurality of different directions, and said radiation detector detecting radiation in said x-ray beam attenuated by said organ at each of said directions, to obtain a

plurality of sets of projection data of said organ in rapid succession, each set of projection data representing a test image of said organ, during at least one rotation of said focus around said organism and during a duration at least equal to a period of said movement of said organ; and

a computer supplied with said projection data, said computer analyzing said sets of projection data to determine whether said projection data in each set were acquired during a respective rest phase of at least one of said regions of said organ by detecting movement artifacts in an image region of each test image containing said at least one region of said organ, and designating projection data in respective test images that are free of movement artifacts as having been acquired during the rest phase of said at least one of said regions, and reconstructing a diagnostic image of the organ using only projection data from said test images acquired during said respective rest phase of said at least one of said regions.

15. A computed tomography apparatus as claimed in claim 14 wherein said organ is the heart of said organism, and further comprising an ECG unit adapted to interact with the heart to obtain an ECG signal therefrom in parallel with said projections, said ECG unit supplying said ECG signal to said computer and said computer identifying a time interval from said ECG signal corresponding to said respective rest phase of said at least one of said regions, and said computer using only projection data obtain during said interval for reconstructing said image of the heart.

16. A method for generating a computed tomography image of a periodically moving organism of an organism, wherein the organ comprises a plurality of regions each having a rest phase and a movement phase, with the respective rest phases of different ones of said regions ensuing at different points in time, comprising the steps of:

(a) emitting an x-ray beam from a focus of an x-ray source and rotating at least said focus around said organ to irradiate said organ from a plurality of different directions, and detecting x-rays in said x-ray beam attenuated by said organ at each of said directions, to obtain a plurality of sets of projection data of said organ in rapid succession, each set of projection data representing a test image of said organ, during at least one rotation of said focus around said organ and during a duration that is at least equal to one period of the periodic movement of the organ, each of said projections comprising projection data and in parallel with the acquisition of said projections, acquiring a signal from said organ representing a physiological function of said organ, said signal reflecting said periodic movement of said organ;

(b) analyzing said sets of projection data to determine whether the projection data were acquired during a rest phase or during a movement phase of at least one of said regions of said organ identifying a time interval in said signal corresponding to the respective rest phase of said at least one of said regions, and identifying projection data for said region obtained during said time interval; and

(c) reconstructing a diagnostic image of said organ using only projection data acquired during the respective rest phase of said at least one of said regions of said organ.

17. A computed tomography apparatus for generating an image of a periodically moving organ of an organism, said organ comprising a plurality of regions each having a rest phase and a movement phase, with the respective rest phases of different regions of said organ ensuing at different points in time, said computed tomography apparatus comprising:

an x-ray source having a focus from which an x-ray beam is emitted;

a radiation detector on which said x-ray beam is incident;

at least said focus of said x-ray source being rotatable around said organism to irradiate said organ in said organism from a plurality of different directions, and said radiation detector detecting radiation in said x-ray beam attenuated by said organ at each of said directions, thereby producing a plurality of projections, during at least one rotation of said focus around said organism and during a duration at least equal to a period of said movement of said organ, each of said projections comprising projection data in parallel with the acquisition of said projections, acquiring a signal from said organ representing a physiological function of said organ, said signal reflecting said periodic movement of said organ; and

a computer supplied with said projection data, said computer analyzing said projection data to determine whether said projection data in each set were acquired during a respective rest phase of at least one of said regions of said organ, and reconstructing an image of the organ using only projection data from said respective rest phase of said at least one of said regions identifying a time interval in said signal corresponding to the respective rest phase of said at least one of said regions, and identifying projection data for said region obtained during said time interval.

18. A computed tomography apparatus as claimed in claim 17 wherein said organ is the heart of said organism, and further comprising an ECG unit adapted to interact with the heart to obtain an ECG signal therefrom in parallel with said projections, said ECG unit supplying said ECG signal to said computer and said computer identifying a time interval from said ECG signal corresponding to said respective rest phase of said at least one of said regions, and said computer using only projection data obtain during said interval for reconstructing said image of the heart.

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